

Long-Term Stewardship

Geographic Information System Pilot Project

Final Report

for the

U.S. Department of Energy Grand Junction Office

October 2002

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1.0 Summary

This document is the final report for U.S. Department of Energy Grand Junction Office (DOE–GJO) Long Term Stewardship (LTS) Geographic Information System (GIS) Pilot Project. The scope of this pilot project was to develop a web-based GIS for the DOE–GJO Long-Term Surveillance and Maintenance (LTSM) Program stewardship sites for use by all stakeholders, including DOE, regulatory agencies, LTSM Program staff, and local community members.

This project was conducted in three phases. The first phase consisted of assessing the information needs and developing web application specifications. Based on these requirements, a prototype web application was developed and demonstrated. This was followed by final development and deployment of basic mapping data layers and environmental monitoring information, including water quality and water levels for existing wells at 28 LTSM sites. Access to the Geospatial Environmental Mapping System (GEMS) has now been incorporated onto each of the 28 LTSM sites' web pages.

Many of the comments received during prototype demonstrations were beyond the scope of this pilot project. However, DOE–GJO's LTSM Program has included scope for fiscal year 2003 to further enhance GEMS. Readers of this report and users of GEMS are encouraged to submit any additional comments or ideas to gems@gjo.doe.gov.

2.0 Background/Overview

The DOE Headquarters Office of Long-Term Stewardship issued a call for pilot projects that would aid individual sites, especially closure sites, in resolving barriers to the transition to LTS or that would help resolve LTS implementation issues across the DOE complex. The DOE–GJO proposal to enhance communication with stakeholders by developing an Internet-based GIS for the sites currently in the LTSM Program was one of the pilot projects selected. An Internet-based GIS was believed to be an effective means of long-term management and dissemination of technical, operational, and monitoring information to the various stakeholders.

This final report discusses the activities conducted, issues, and other general conclusions that were made and the lessons learned as a result of this pilot project.

3.0 Discussions

The scope of this project was to develop a web-enabled GIS for the DOE–GJO LTSM sites. The project consisted of three phases: (1) requirements and infrastructure, (2) prototype development, and (3) final development. The project schedule is shown on [Figure 1](#).

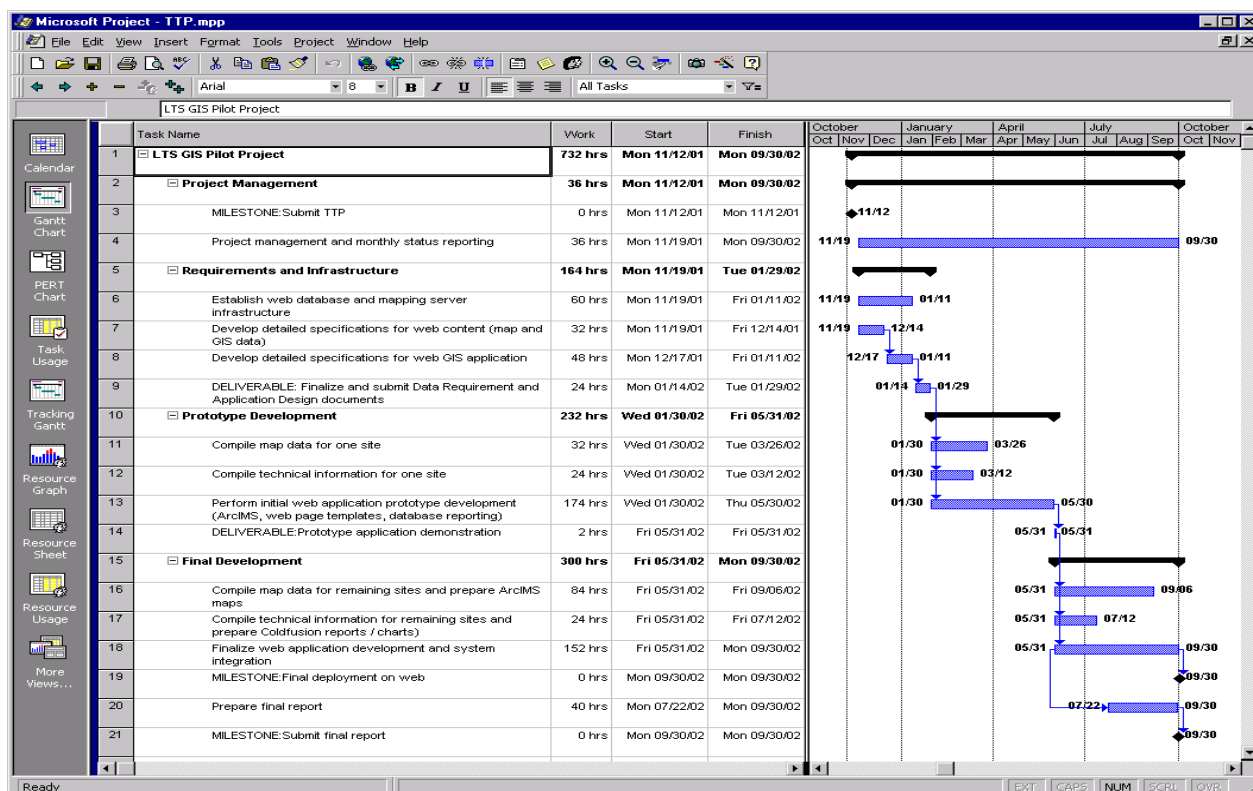


Figure 1. LTS GIS Pilot Project Schedule

3.1 Requirements and Infrastructure Phase

3.1.1 Requirements

To determine information and user-interface requirements, a list of representative stakeholders was developed and a questionnaire was prepared. The selection of stakeholders to receive the questionnaire was based on input from LTSM Program and DOE–GJO staff. The primary criterion was that an individual had a vested interest in one or more of the LTSM sites or was currently involved with LTS activities. Questionnaire recipients included contractors, DOE personnel, regulators, lawmakers, and other members of the public. Results of this initiative were presented in the “*Information Needs Assessment and Web Application Specifications for the Long-Term Stewardship Geographic Information System Pilot Project at the U.S. Department of Energy Grand Junction Office, March 2002.*” This report is available on the LTS GEMS website <http://gems.gjo.doe.gov>; click on the hyperlink “LTS GIS Needs Assessment Report.”

The questionnaire responses were from a diverse audience with varying degrees of web-application requirements and varying levels of detail in the information they require. Also, this pilot project spans 28 LTSM sites across the United States. Therefore, the information made available and the environmental tools developed were generalized. In the future, audience-specific and site-specific functionality and information enhancements will be required.

General conclusions presented in the needs assessment report were:

- Significant interest exists to make information pertaining to compliance and monitoring activities at the LTSM sites available on an Internet-based GIS website.
- Timely availability of dynamic (current) spatial data associated with a site is of particular interest.
- Special information requirements resulting from unique site monitoring or maintenance activities exist.
- User information needs and the utility offered by an Internet-based GIS may vary, depending on the audience.
- The long-term viability of an Internet-based GIS will hinge on the cost effectiveness and timeliness of new data being made available.

Three categories of web-application specifications were developed:

General Specifications

- Fully integrate the LTS GIS into the existing LTSM Program website.
- Provide for easy addition of sites as they are transferred to the LTSM Program.
- Provide an opening introductory screen that describes the purpose of this website with links to resources such as instructions, glossaries, and contacts.
- Provide users with the option to submit comments or questions regarding the website.
- Provide general and context-sensitive help throughout the system.
- Provide links to other websites as appropriate.
- Provide standard navigation and map tools, including zoom in, zoom out, pan, identify, and measure.
- Provide standard feature control so users can turn on and turn off data layers of interest.

Security Specifications

- LTSM Program management, Public Affairs, Security, and Information Technology staff members at the GJO, representing DOE and the contractor, must approve the information types that will be made available.

Functionality Specifications

- Allow key information about the site to be displayed on the site overview map.
- Display only validated data.
- Allow different types of monitoring locations to be displayed.
- Display ground water monitoring locations based on cell performance, ground water compliance, or other factors.
- Provide query tools that dynamically chart and report data for the analyte of interest for a given monitoring location.

- Use symbols, where appropriate, based on regulatory standards.
- Allow generalized monitoring data queries for the site to be performed and an option to download data, (not currently available).

Results of the information needs assessment indicate that features and information of greatest need were:

1. Monitoring locations (monitor wells, boreholes, surface sample and air monitoring locations)
2. Site boundary
3. Plume (extent of boundary or concentration contours)
4. Topographic contours
5. Disposal cell boundary
6. Photographs (current and historical)
7. Ground water compliance monitoring network
8. Parcel, DOE-acquired tract, or lease boundary
9. Institutional control boundary
10. Cell performance monitoring network
11. Monitor well lithology and completion logs
12. Aerial photographs or satellite imagery
13. Potentiometric surface contours

3.1.2 Infrastructure

The underlying architecture for this pilot project is:

- Compaq ProLiant ML530R Pentium III XEON
- Oracle Database Standard Edition (Universal Data Server) Version 9.2
- Arc/IMS Version 4.0
- Macromedia Dreamweaver UltraDev Version 4.0
- Macromedia ColdFusion Server Version 5.0
- Steema Software SL teeChart Pro Version 5.02

3.2 Prototype Development Phase

Based on the requirements established in the requirements and infrastructure phase, a prototype website was developed for the Shiprock, New Mexico, disposal site and the Rifle, Colorado, (Estes Gulch) disposal site. Development of the prototype website, known as GEMS, consisted of compiling mapping data layers into a GIS compatible format for these two sites, working through the logistics of making environmental monitoring data available on the web server, addressing integration with the existing web pages for these LTSM sites, identifying navigation tool requirements, and identifying environmental tools requirements.

Once the mapping data layers were displayable and database connectivity was established, the emphasis was on developing the customized environmental tools. For this pilot project, the focus was on the ability to select a well and have water quality and water level information returned in table form.

Prototype demonstrations were given to LTSM Program staff, DOE–GJO staff, and personnel from the Colorado Department of Public Health and Environment. The recipients provided general comments on web page navigation, integration within the existing LTSM website, and interactive mapping page navigation and layout. They also expressed significant interest in the environmental tools being developed and ways to enrich the environmental tool set. Ideas included:

- Need the ability to select multiple wells for obtaining water quality or water level information.
- Incorporate simple distance and area tools.
- Include regulatory limit information for the analyte(s) selected.
- Add the ability to show or highlight wells in which analyte concentrations exceed a regulatory limit or a specified value.
- Display an initial map of the United States that could be used for site selection and for displaying site information. Symbolize sites by type (former processing, disposal, etc.), category (Title I, Title II, etc.), or other criteria.
- Display other sampling location types besides wells. Symbolize accordingly.
- Provide a drop-down list for wells so they can be displayed based on various criteria, such as well type, zone of completion, existence, exceedance of a standard. Symbolize accordingly.
- Provide a drop-down list for contaminant plumes so different plumes can be displayed by year, analyte, or other criteria.
- Provide a drop-down list for sets of photo points so various or all can be shown. For example, be able to display site inspection photos by year.
- Allow environmental data and mapping data layers to be exported in industry standard formats. For data, this might include ASCII text (comma delimited or fixed format), Excel worksheet, or Access table. For mapping data layer, this might be in shapefile format.
- Customize sites that have unique monitoring requirements. Develop specialized tools as required. For example, at the Rifle disposal site, display cell dewatering and pumping information.
- Develop the ability to perform an interactive data query by inputting the sampling locations of interest rather than by selecting them graphically. Queries could return information such as monitoring location detail, well construction, water quality, and water levels.

Though most of these enhancements were beyond the scope of this pilot project, scope and funding for additional GEMS development has been included in the DOE–GJO LTSM Program task order for fiscal year 2003.

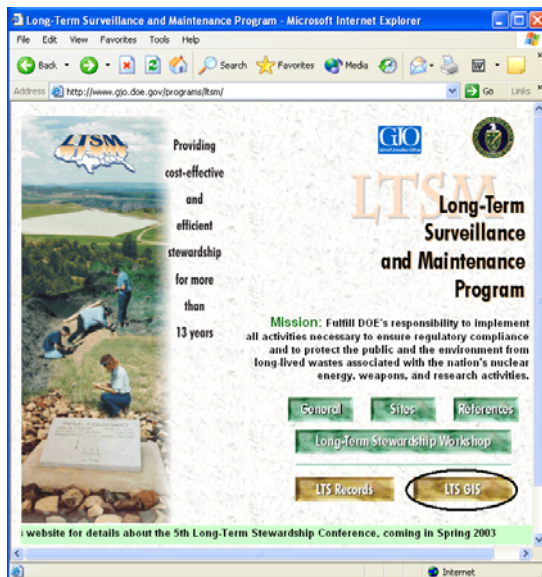
3.3 Final Development Phase

The final development phase included compiling mapping data layers for the remaining 26 LTSM sites, refining the navigation and environmental Arc/IMS tools, and integrating as many of the comments and suggestions as the scope of the pilot project allowed.

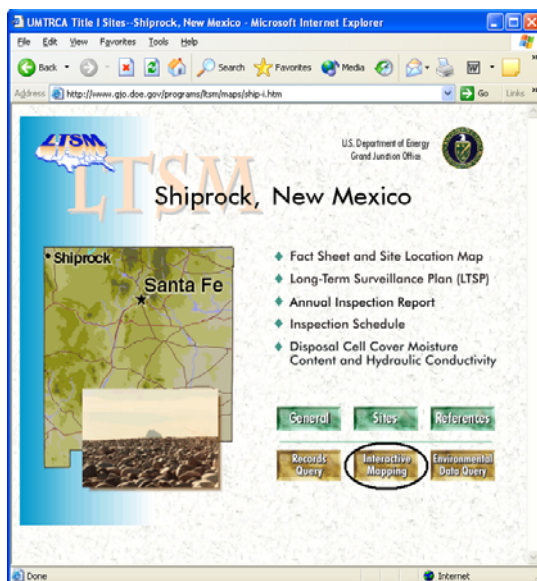
The GEMS site utilizes Java scripting and ActiveX controls. As a result, Internet Explorer version 5.0 or newer is required and security settings must allow ActiveX and Java scripting. To allow them, the Internet Explorer ActiveX and Java Security settings can be enabled or the GEMS site can be added as an Internet Explorer trusted site.

There are three ways to access GEMS:

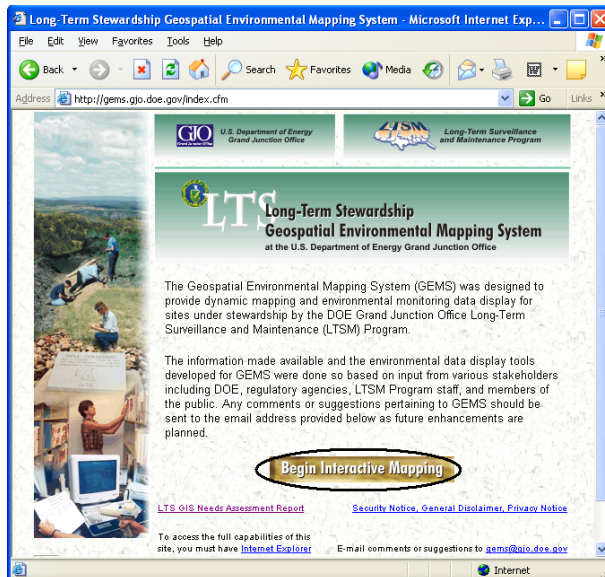
1. Enter the URL <http://gems.gjo.doe.gov>.
2. Click the “LTS GIS” button on the LTSM home page
<http://www.gjo.doe.gov/programs/ltsm>.



3. From an LTSM site page, click the “Interactive Mapping” button.



From any of these options, the GEMS welcome screen is displayed. If option 1 or 2 is used, a site-selection drop down box is also visible on this welcome screen enabling the user to specify the site of interest. Pressing the Begin Interactive Mapping button initiates the GIS for that site.

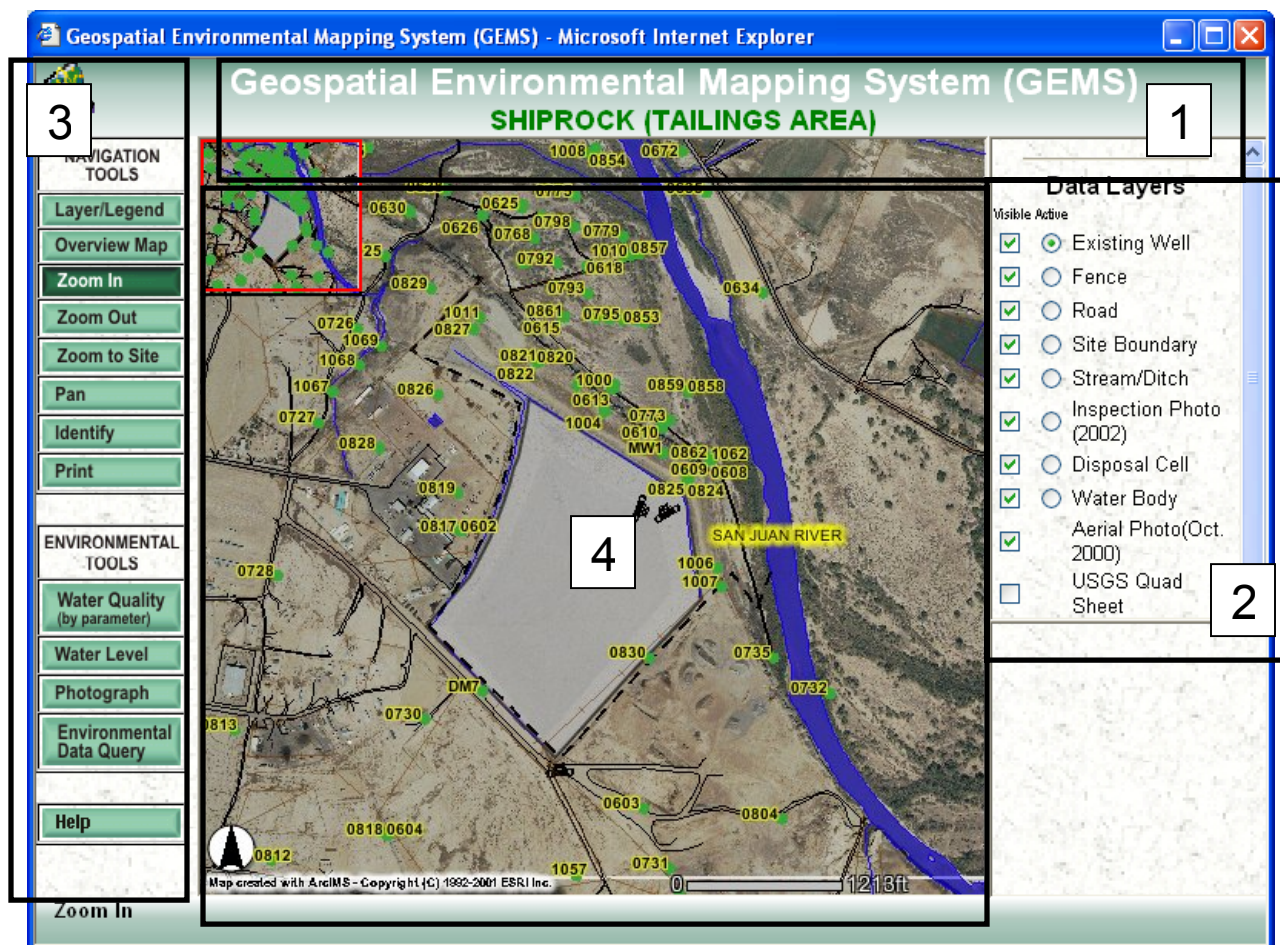


Data layers currently displayable on GEMS, if available for the site, include:

- Existing wells
- Fences
- Roads
- Site boundary
- Stream/ditches
- Water bodies
- Disposal cell boundary
- Annual site inspection photographs (from the most recent inspection)
- Aerial photography (most recent available)
- USGS 1:24000 quadrangle

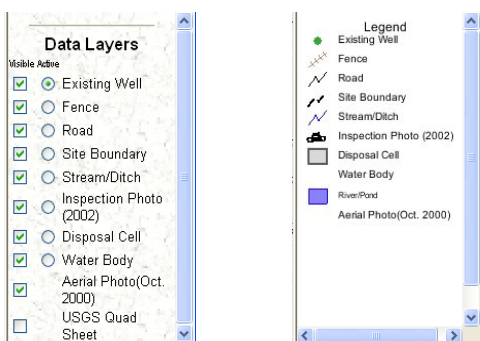
The GEMS window consists of four primary frames:

1. Site title frame
2. Data layer/legend frame
3. Toolbar frame
4. Map frame



In the data layer/legend frame, the user can turn data layers on and off by clicking the Visible box in the data layer frame. The map is automatically updated.

Using the **Layer/Legend** tool, the user can also toggle between data layers being displayed or a legend.



In the toolbar frame, map navigation and other general tasks can be performed using the tools in the Navigation Tools portion of the toolbar frame.

NAVIGATION TOOLS

Layer/Legend	Toggles between the data layer and legend frame.
Overview Map	Toggles the overview map shown in the upper left corner of the map frame on or off.
Zoom In	Zooms in on a position clicked or a box dragged on the map.
Zoom Out	Zooms out on a position clicked or a box dragged on the map.
Zoom to Site	Zooms to the extents of the site boundary data layer.
Pan	Pans the map as the user drags the pointer across the map.
Identify	Lists the attributes of the feature you identify in the active data layer by clicking on it in the map.
Print	Prints the map.

Also in the toolbar frame, environmental monitoring information is accessible from the Environmental Tools portion of the toolbar frame.

ENVIRONMENTAL TOOLS

Water Quality (by parameter)

Once the Water Quality button is pressed, wells can be clicked on to obtain water quality information. When the Chemistry Form appears, the user can select one or more analytes by clicking on them and entering the date range of interest. The default date range is based on the first and last dates that samples were collected for that location.

Chemistry Form - Microsoft Internet Explorer

Back Forward Stop Home Search Favorites

LTS Long-Term Stewardship Geospatial Environmental Mapping System
at the U.S. Department of Energy Grand Junction Office

CHEMISTRY DATA

SITE: SHP02, SHIPROCK (TAILINGS AREA)
LOCATION: 0826 [well] Just West of Disposal Cell, NECA yard, flush mount.
FLOW RELATIONSHIP:
ZONE OF COMPLETION: ALLUVIUM / MANCOS SHALE

Choose one or more analytes:

Trichloroethene
Trichlorofluoromethane
Trichlorotrifluoroethane
Turbidity
Uranium

Enter date range:

Start Date: 13-Dec-1998 **End Date:** 21-Mar-2002

Submit Close

From the report, the View Graph button can be pressed to view a time-concentration graph. The View Log button can be pressed to view the Monitoring Well Completion Log. The Modify Query button can be used to change the analytes and date range previously selected.

Example time-concentration report

Chemistry Results - Microsoft Internet Explorer

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LTS Long-Term Stewardship
Geospatial Environmental Mapping System
at the U.S. Department of Energy Grand Junction Office

CHEMISTRY DATA

SITE: SHP02, SHIPROCK (TAILINGS AREA)

LOCATION: 0826 [well] Just West of Disposal Cell, NECA yard, flush mount.

FLOW RELATIONSHIP:

ZONE OF COMPLETION: ALLUVIUM / MANCOS SHALE

View Graph View Log Modify Query

ANALYTE	UNIT	SAMPLE:		RESULT	QUALIFIERS:			DETECTION LIMIT	UN-CERTAINTY
		DATE	ID		LAB	DATA	QA		
Uranium	mg/L	12/13/1998	0001	2.86			True		
Uranium	mg/L	03/04/1999	0001	3.04			True		
Uranium	mg/L	06/08/1999	0001	3.4			True		
Uranium	mg/L	02/04/2000	0001	3.08		L	True		
Uranium	mg/L	06/13/2000	0001	2.95		L	True	0.001	
Uranium	mg/L	02/13/2001	0001	3.43		L	True	0.01	
Uranium	mg/L	09/19/2001	0001	3.26			True	0.0025	
Uranium	mg/L	03/21/2002	0001	2.87		F	True	0.001	

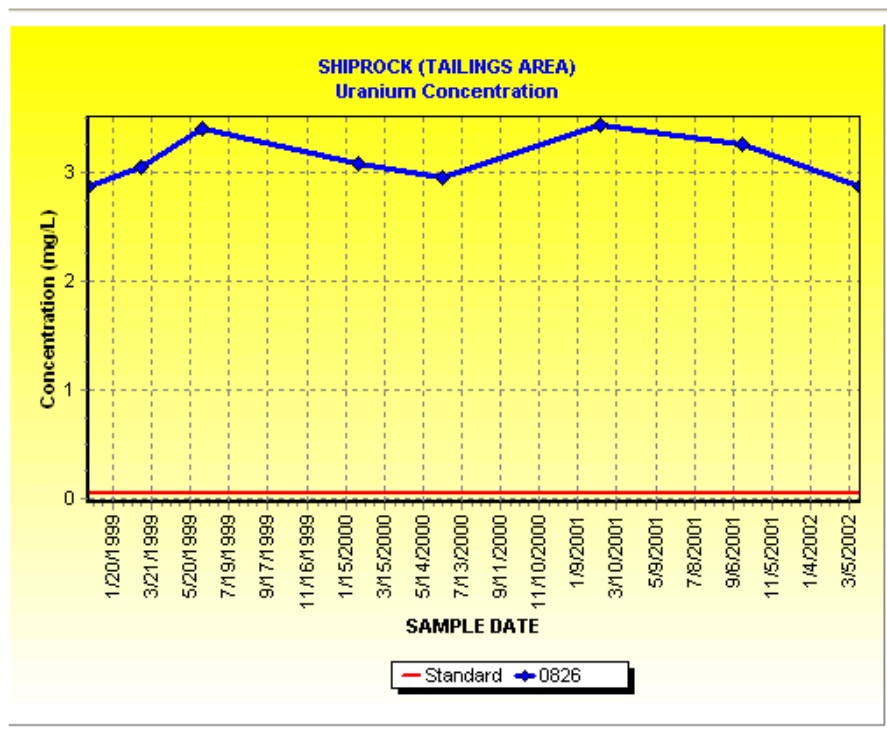
SAMPLE ID CODES: 000X = Filtered sample (0.45 µm). N00X = Unfiltered sample. X = replicate number.

LAB QUALIFIERS

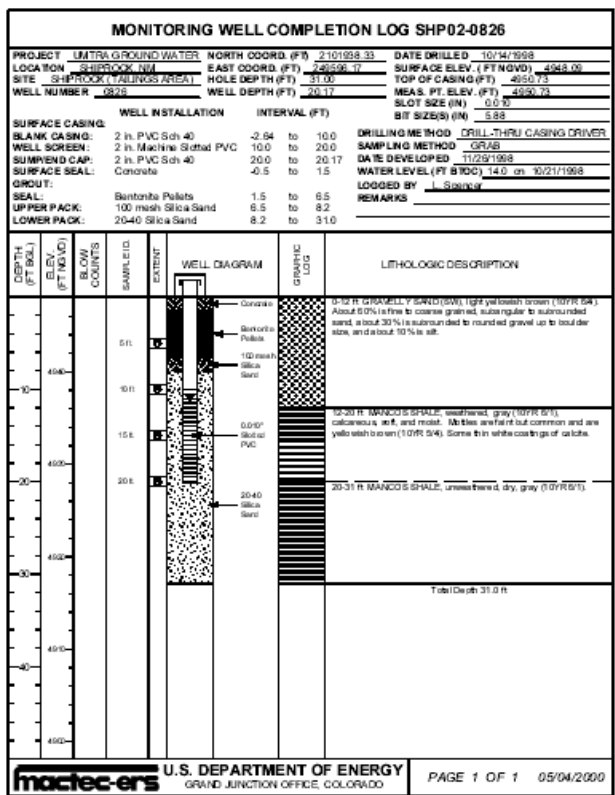
QUAL DESCRIPTION

- * Replicate analysis not within control limits.
- + Correlation coefficient for MSA < 0.995.
- ~ Result above upper detection limit.

Example time-concentration graph



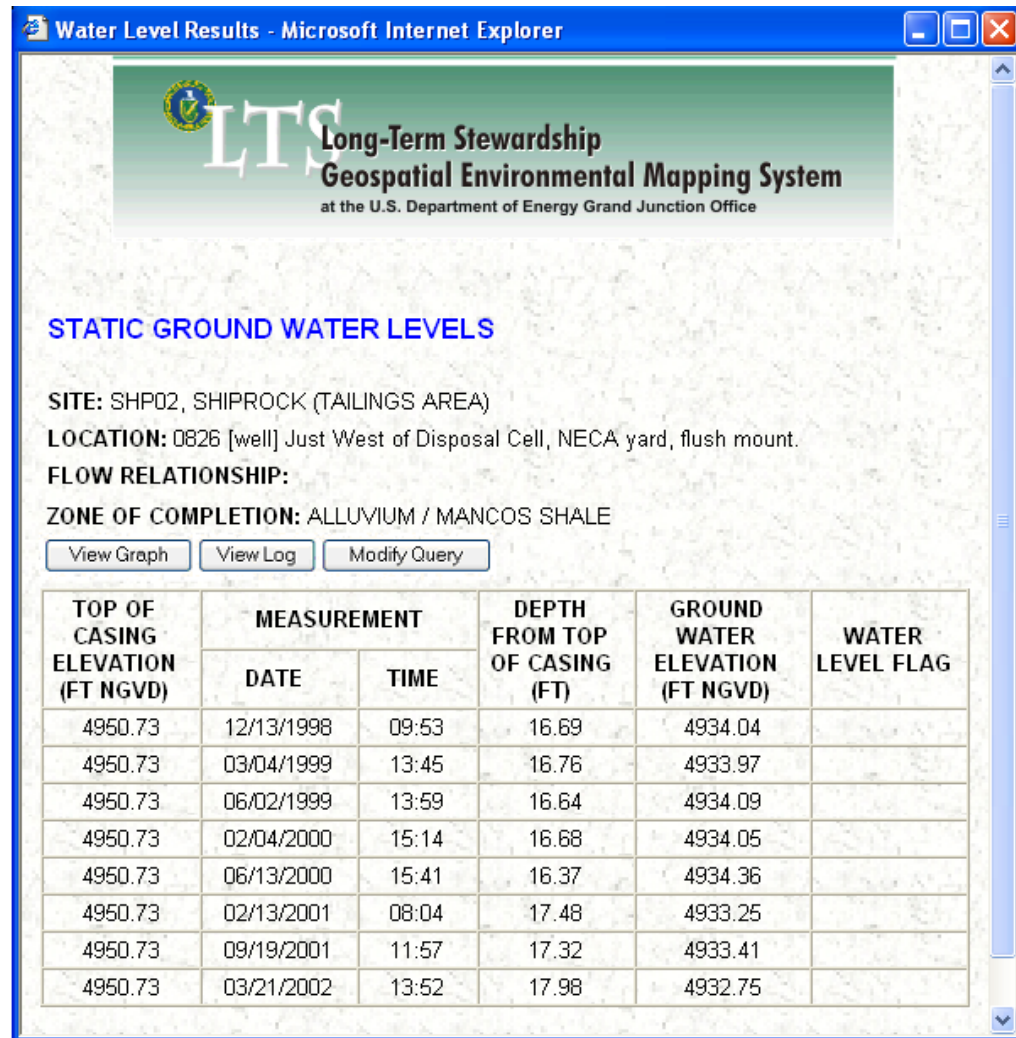
Example Monitoring Well Completion Log



Water Level

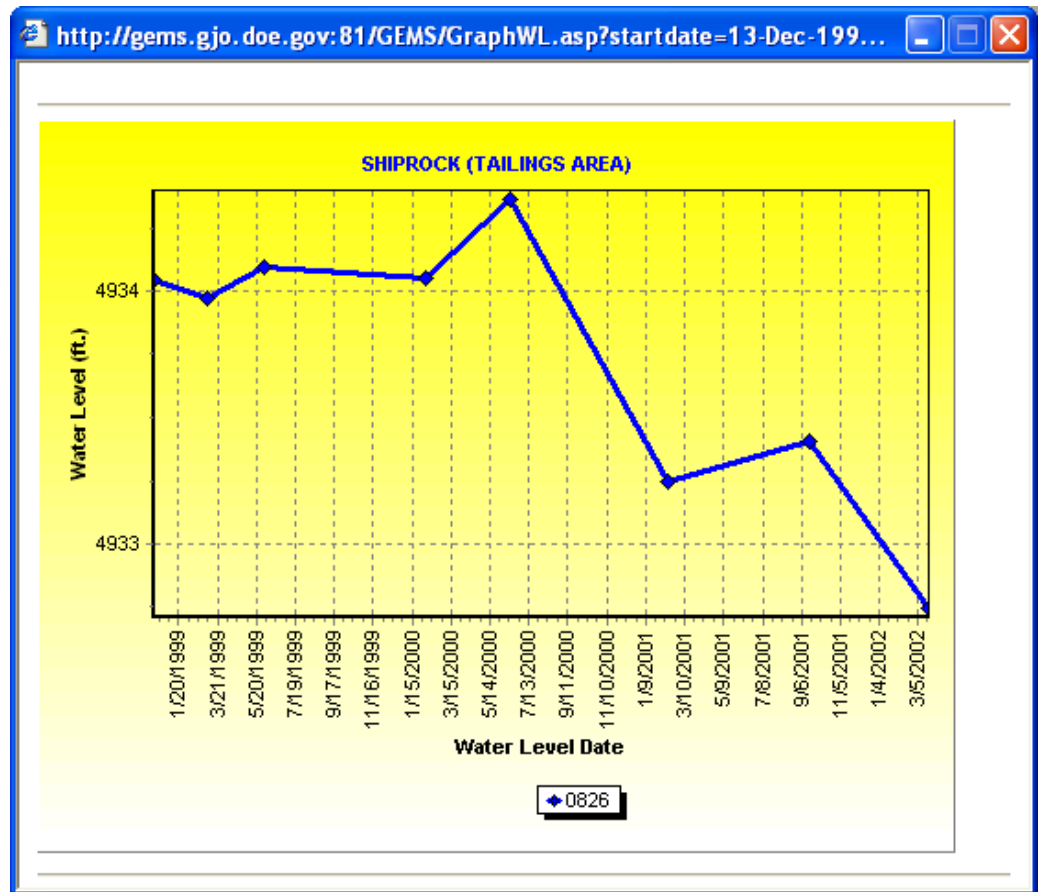
Once the Water Level button is pressed, wells can be clicked on to obtain water level information. When the Water Level form appears, the user can enter a date range other than the default. The default date range is based on the first and last dates that water levels were measured for that location.

Example water level report



From the report, the View Graph button can be pressed to view a hydrograph. The View Log button can be pressed to view the Monitoring Well Completion Log. The Modify Query button can be used to change the date range previously selected.

Example hydrograph



Photograph

Once the tool is clicked on, photo points can be clicked on to display the photograph.

Example photograph



Environmental Data Query

This tool will allow the user to query environmental data by parameter entry rather than by spatial selection. (Currently not available)

Help

Displays GEMS Users Guide

4.0 Issues/Conclusions

The following are issues and other general conclusions resulting from this pilot project:

- Ongoing management of mapping data layers and environmental monitoring data in a timely fashion is not only a best business practice but is now of greater importance since one of the primary reasons a user would visit such a site is timely and accurate display of information.
- LTS GIS mapping data layers should be managed in a GIS format, as feature attributing preserves knowledge about it.

- As the ability to export mapping data layers becomes available, metadata (information about the data) also becomes an important issue.
- The information made available and the tools developed will not meet the needs of all GEMS users due to the diversity of the audience.
- Current and historical aerial photography and site photography libraries have significant value.
- Once such a GIS infrastructure is available, adding new sites as they enter long-term stewardship is relatively straightforward after the mapping data layers are compiled and standardized and the environmental monitoring data are converted into the standardized format.

5.0 Lessons Learned

One of the important aspects of the LTS pilot project program is the sharing of lessons learned. Several lessons learned as a result of this project are noteworthy.

- Information needs assessments should be well planned and perhaps targeted at a specific audience or site. Generalized conclusions had to be drawn, and the information made available had to be simplified. The upside was that the work had to be done in a non site-specific fashion, thus preventing customization to the point of non-usability across the sites.
- Because of the number of sites involved, common data organization and standardized data formats became even more important. Also, the general data management process and associated rigor had to be reviewed and will be improved as a result of this pilot. For example, managing site inspection photographs and the associated photograph log for the purpose of including them in a trip report and putting a graphical point on a drawing was found to be insufficient for the purpose of displaying them on GEMS. The photograph point needed to carry attributes, or information, about it. These attributes not only included coordinates, but azimuth, description, date, file location of the digital image, and other information that will be of importance to LTS sites. Attributes are as important as the feature itself.
- A project of this kind required the integration of many functional and technical disciplines. These included knowledge of environmental data, mapping, GIS, database administration, an understanding of user needs, and all the technologies and skills required for deploying such a web-based solution.
- Because site environmental monitoring information will be more readily available, time and cost savings for information retrieval and dissemination are likely for both the steward and the stakeholders. Also, the timely communication of new information between the two parties has been enhanced.